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Benthic Communities and Non-target Fish Species

Stock-recruitment relationships for Bristol Bay red king crabs

Jie Zheng, ADF&G, Juneau, Alaska, email: jie_zheng@fishgame.state.ak.us

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The results from a length-based model were used to develop stock-recruitment (S-R) relationships for Bristol Bay red king crabs, 1968-1997. Male reproductive potential is defined as the mature male abundance by carapace length multiplied by the maximum number of females with which a male of a particular length can mate (Zheng et al. 1995). If the mature female abundance was less than the male reproductive potential, then the mature female abundance was used as female spawning abundance. Otherwise, female spawning abundance was set equal to the male reproductive potential. The female spawning abundance was converted to biomass and defined as the effective spawning biomass (SPt). The S–R relationships of Bristol Bay red king crabs were modeled using a general Ricker curve:

$$R_t = SP_{t-k}^{r1}\, e^{r2 - r3\, SP_{t-k} + v_t}, \quad (1)$$

and an autocorrelated Ricker curve:

$$R_t = SP_{t-k}\; e^{r2 - r3\, SP_{t-k} + \upsilon_t}, \quad (2)$$

where

$$\upsilon_t = \delta_t + a1\ \upsilon_{t-1},$$

v_t, δ_t are environmental noises assumed to follow a normal distribution $N(0,\sigma^2)$, $r1$, $r2$, $r3$, and $a1$ are constants.

Generally, strong recruitment occurred with intermediate levels of effective spawning biomass, and very weak recruitment was associated with extremely low levels of effective spawning biomass (Figure 79). These features suggest a density-dependent S–R relationship. On the other hand, strong year classes occurred in the late 1960s and early 1970s, and weak year classes occurred in the 1980s and 1990s. Therefore recruitment is highly autocorrelated, so environmental factors may play an important role in recruitment success. The general Ricker curve ($R^2 = 0.54$) was used to describe the density-dependent relationship and the autocorrelated Ricker curve ($R^2 = 0.44$) was used to depict the autocorrelation effects. The recruitment trends of Bristol Bay red king crabs may partly relate to decadal shifts in physical oceanography: all strong year classes occurred before 1977 when the Aleutian Low was weak. The largest year class during the last 20 years, the 1989 brood year, was also coincidental with the weak Aleutian Low index during 1989-1991.

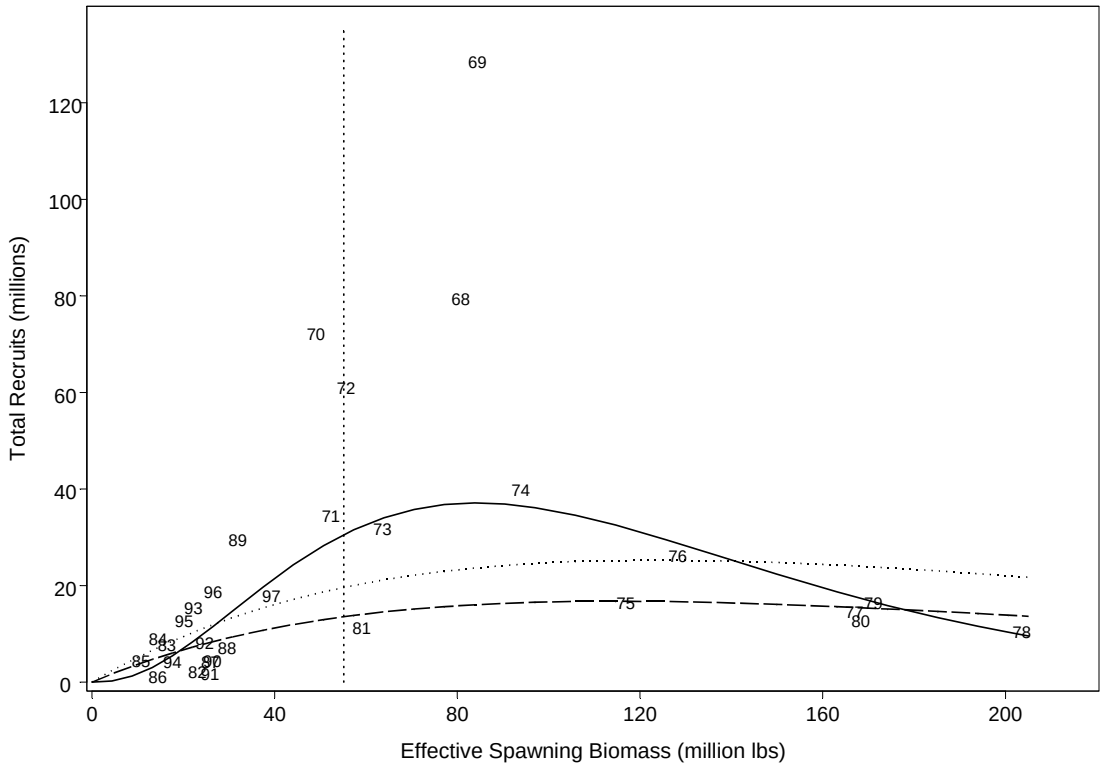

Figure 79. Relationships between effective spawning biomass and total recruits at age 7 (i.e., 8-year time lag) for Bristol Bay red king crabs, 1968-1997. Numerical labels are brood year (year of mating), the solid line is a general Ricker curve, the dotted line is an autocorrelated Ricker curve without υt values (equation 2), and the dashed line is a Ricker curve fit to recruitment data after 1974 brood year. The vertical dotted line is the targeted rebuilding level of 55 million lbs effective spawning biomass.